DEPARTMENT OF AGRICULTURE,
CEYLON.

BULLETIN No. 29.

DISEASES OF HEVEA BRASILIENSIS.

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DISEASES OF HEVEA BRASILIENSIS.

By G. BRYCE, B.Sc.

IN the present Bulletin the principal facts of the diseases of Hevea have been arranged in a form suitable for ready reference by planters. It is hoped that the short descriptions given will facilitate the recognition of the various fungi parasitic on Hevea. The measures to be adopted in the eradication or prevention of a disease depend upon its mode of occurrence. With a view to reducing opportunities for attack, greater care should be taken to avoid practices which provide suitable conditions for the development of disease. The following is a list of the principal diseases :—

Fomes lignosus (= Fomes semitostus).

Hymenochæte noxia, or brown root disease.

Ustulina zonata.

Poria hypobrunnea.

Corticium salmonicolor, or pink disease.

Botryodiplodia theobromæ, or dieback and diplodia disease.

Phytophthora diseases :—

Stem canker.

Abnormal leaf fall.

Fruit disease.

Bark rot of the tapping surface.

FOMES LIGNOSUS (= FOMES SEMITOSTUS).

Identification.—Early stages show the root covered with white mycelium forming white or yellowish strands. The fructification appears first as a small orange-yellow cushion, and then develops into a bracket-shaped plate attached to the

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tree along its hinder margin. It can be identified by its colours but only fresh specimens should be examined, as the colours change on drying. Upper surface rich red-brown; margin bright yellow; under surface studded with minute holes and bright orange. On drying, or when old, the upper surface becomes pale yellow-brown with concentric darker lines; the lower surface becomes red-brown, *i.e.*, the upper surface bleaches, the lower surface darkens. On breaking in two, the fracture shows an upper layer white and fibrous, and lower or pore layer red-brown. This last point in most cases serves to distinguish Fomes from a common harmless fungus (*Polyporus zonalis*), which resembles it in the colour of the upper surface, but has usually a white or pallid fracture.

Occurrence.—In clearings the fungus starts on old jungle stumps, especially old jak or *Ficus* stumps, to which its spores are carried by the wind and there germinate and grow, finally penetrating the wood of the stump in all directions. The fungus may start similarly on Hevea stumps left exposed above ground after thinning. Where tea is allowed to die out under Hevea, the fungus, once it gains entrance, spreads rapidly along the dead or dying tea roots. Fomes either originates on the tea stumps or utilizes them as a means of passage from one Hevea to the next. Fomes can spread from diseased roots to healthy roots where these are in contact, and can also spread independently of roots by sending out strands which penetrate the soil in all directions in search of food. The fructification forms on the tree some months after it has died, appearing at the base near the soil level; it also develops along the whole length of fallen trees killed by Fomes.

Treatment.—Dead trees must be removed as completely as possible and burnt. Where dead trees occur in patches round a jungle stump, the latter also must be dug out and burnt. Main roots and laterals of Hevea and jungle stumps must be followed up and removed.

The apparently healthy trees round the affected area should be examined by laying bare their tap roots, as it is quite possible that fungus threads may have already reached

them; if their tap roots are decayed, the trees must be removed, but if only one of the lateral roots is attacked, it should be cut off and the cut tarred. When the extent of the patch is determined, a trench 2 feet deep must be dug round it. The ground enclosed by the trench must be dug over to a depth of 2 feet and all dead wood removed. A liberal dressing of quicklime should be forked in. The patch and the trench should be kept clear of weeds.

Brown Root Disease (Hymenochæte noxia).

Identification.—The roots, especially the tap root, are encrusted by a mass of sand, earth, and small stones, and this may extend up the stem above ground level for several inches. This mass is cemented to the root by the mycelium of the fungus, which consists of tawny brown threads collected here and there into small brown patches.

In the early stages the predominating colour is brown, but as it grows older the fungus forms a black, continuous covering over the brown masses of hyphæ, and the diseased root then appears chiefly black. In all stages, however, the encrusting mass of stones and earth, intermingled with brown threads, serves to distinguish it.

Occurrence.—This fungus attacks rubber, tea, cacao, dadap, and many other plants. It spreads from diseased to healthy roots where these are in contact, but this is a very slow process. It does not send out independent strands into the soil. It is the only root disease of cacao known in Ceylon, and develops freely whenever cacao is cut down. It is thus specially to be feared where cacao has been cut out of mixed Hevea and cacao.

Treatment.—Dead trees should be removed with as much of the roots as possible and burnt. Neighbouring cacao stumps should be dug up. As a rule, the whole of the fungus is removed with the dead tree. Consequently it is rarely found that a neighbouring tree dies after the first dead tree has been got rid of. It is advisable, however, to dig over the affected spot and fork in quicklime. It should be possible to re-plant in the same spot in a very short time.

USTULINA ZONATA.

Identification.—This fungus is the cause of the commonest tea root disease in Ceylon. The fungus at first forms a white, soft plate, which lies flat on the stem. This plate soon turns greenish, then becomes purple gray and hard and crusty, finally becoming black. Its brittle crusty texture is a good distinguishing character. It sometimes shows slight concentric undulations.

Occurrence.—This fungus attacks Casuarina, pumelo, *Cassia nodosa,* halmilla, lunumidella, *Derris,* tea, &c. In the case of tea, the fungus generally begins on the stump of a felled Grevillea, and spreads along the lateral roots; where these are in contact with tea roots, the fungus enters the tea root. It spreads from abandoned tea to Hevea, and has also been found on cacao stumps and Hevea stumps after thinning out. It attacks Hevea in three ways. It is most serious as a root disease, usually attacking a lateral root, and from that spreading to one side of the stem and tap root. Its effects are often local, a decayed area extending up only one side of the stem, but sometimes part of the crown dies as the roots are killed. Another mode of attack is through wounds on the stem where the wood is exposed, such exposure often being due to previous attacks of canker or pink disease. Finally, the fungus may develop from the fork of a tree without any previous wound. In this case the fungus develops down the trunk, and its fructification may cover a foot or more of the trunk.

Treatment.—Cut away the parts attacked at the base of the tree and remove the diseased lateral roots. Tar the cut surfaces. The tree may thus be saved. If badly attacked, remove the tree and the roots and burn. To prevent attack through wounds, these should all be tarred. The forks of trees should be cleaned up and tarred.

When a diseased tree has to be removed, the usual procedure should follow, of digging a trench round the spot, throwing the excavated earth inside, and forking in quicklime. It is of especial importance to dig out as much of the root system as possible. It should be possible to re-plant after a few months.

Poria hypobrunnea.

Identification.—This is a new root disease caused by a new species of Poria discovered at Peradeniya about two years ago. The mycelium on the root forms stout red strands. When old, these turn black, and sand and small stones often adhere to the mycelium. The fungus forms bright red patches or sheets in the wood of the root. The fructification forms a flat plate lying on the stem, studded with minute holes, at first white or yellowish then reddish. The fracture of the fructification shows the upper layer reddish, and the basal layer blackish-brown.

Occurrence.—We have no record of this disease in Ceylon, except in the neighbourhood of Peradeniya. There it occurred on a new clearing, and also in two localities on Hevea stumps after thinning. These latter furnish another proved case of a root disease originating on Hevea stumps. It has, however, recently been found on Hevea in Malaya, and so it may be expected to be a fairly widespread fungus. On the Experiment Station at Peradeniya it was spreading evidently from decaying jungle stumps and killing young Hevea and *Tephrosia candida.*

Treatment.—Remove jungle stumps and Hevea stumps.

Pink Disease (Corticium salmonicolor).

Identification.—Generally originates at the fork of the tree, or where several branches arise close together. There is at first a pink incrustation on the bark, which gradually increases, and may ultimately cover the whole circumference of the tree and the bases of adjacent branches for a length of several feet. The pink patch is extremely thin, and in dry weather splits into two lines more or less at right angles to one another. Old specimens become bleached to white.

Occurrence.—This fungus attacks Hevea, tea, cinchona, orange, coffee, and is recorded on many other plants in other countries. The disease is conveyed by spores blown by wind ; it is most probable that the fungus develops in the jungle on native trees at the beginning of the monsoon, and the spores

are then blown into the neighbouring plantations. The spores are not produced on old patches of the fungus during dry weather.

Treatment.—In many cases it will be possible to eradicate the disease by cutting away the diseased tissue, if it is discovered before the fungus has grown completely round the tree. If, however, the injury is extensive, the diseased stem must be cut off below the diseased area. All diseased material should be removed and burnt, and the wounds caused by excision or pruning should be tarred.

Diplodia Disease and Dieback (Botryodiplodia theobromæ).

Identification.—This fungus causes two types of diseases in Hevea. In the " dieback " originally described, it attacks the leading shoot and travels down the tree, killing the branches successively as it reaches their junction with the main stem.

In the second form, one side of the tree goes dry, *i.e.*, it does not yield any latex. The cortex is usually discoloured brownish internally, or in some cases the discolouration is found only along the cambium layer. When the fructifications ripen, they extrude black spores, which cover the diseased parts with a sooty powder. The roots of the tree are usually healthy.

Occurrence.—This fungus grows saprophytically on any dead Hevea or cacao material, *e.g.*, dead pods, stems, &c., and on many other plants. It can attack Albizzia and dadaps through wounds. Tissues which have been killed by other fungi, *e.g.*, cankered bark, diseased pods, are subsequently attacked by *Botryodiplodia*. In " dieback " the fungus gains an entrance after the leader has been killed by other fungi. In the other form of the disease, it enters usually through the stub of a dead branch. Where Hevea logs are left lying about after thinning, the fungus develops on them and produces millions of spores, chiefly in the cortex of the log.

Treatment.—Trees attacked by dieback usually occur in groups; some may generally be saved by pruning off the diseased parts. The pruning cut should be sloped and well

tarred. In the second form of the disease badly affected trees should be cut down and burnt, but if only a narrow strip on one side of the tree is diseased, the affected cortex may be cut out and the wound tarred. To prevent attacks, dead branches should be pruned off, and all pruning cuts tarred.

After thinning, the fallen logs should have their bark removed and burnt. The logs should be removed as soon as possible.

PHYTOPHTHORA DISEASES.

The fungus *Phytophthora faberi* causes four well-known diseases of Hevea, viz., stem canker, bark rot of the tapping surface, abnormal leaf fall, and pod disease.

Stem Canker.

Identification.—The bark exudes a reddish or purplish liquid. Healthy Hevea cortex is white, yellowish, or clear red or mottled red and white ; when the outer layer of brown bark is scraped off a green layer is found. In cankered bark this green layer is black, and the cortex if recently diseased is sodden grayish with a well-defined black border to the diseased patch ; but in later stages it is dirty red or claret coloured with a well-defined black border. No latex exudes when cankered bark is cut. The outer layers of bark may be diseased and the inner layers healthy, in which case the latex would exude.

Occurrence.—This fungus causes cacao canker and cacao pod disease. It is disseminated in wet weather by special spores which are blown about by the wind, but require water in which to germinate. Wet stems provide sufficient water for germination. After germination the mycelium penetrates the cortex and destroys it from without inwards. This form of attack is found on the bark, on the tapping cut, and occasionally at the collar of the tree. The fungus mycelium can lie dormant in diseased tissues.

Treatment.—The diseased and discoloured area should be cut out or shaved off. It is not necessary to cut out more than the discoloured area, because the fungus threads have

not advanced beyond it. All tissue excised must be removed and burnt. If the attack is detected at an early stage, it is often possible to entirely shave away the diseased tissue before it has reached the cambium, in which case there is no necessity to cut away the bark right into the cambium. The advantages of prompt detection are thus obvious. Treatment of the shaved surface with 20 per cent. Carbolineum or Brunolinum* is beneficial. If the wounds caused by excision of cankered bark are small, they may be left alone after treatment with Carbolineum. If the wounds are large, the exposed wood should be tarred. The essential point is so to protect exposed wood that boring insects may not enter.

Abnormal Leaf Fall.

Identification.—The leaf stalks of fallen leaves have a dark brown ring about 1 inch long consisting of diseased tissue; from this ring one or two drops of latex may ooze, and these may remain white or turn black. The green twigs bearing diseased leaves may be killed back by the spread of the fungus into them. Again, green twigs may be attacked and drop their leaves, which are in this case apparently healthy, showing no marks of fungus attack.

Occurrence.—This form of attack of *Phytophthora faberi* causes leaf fall during wet weather from July to September. The fungus spreads from the previously diseased pods to the leaf stalks. Its attack on the leaf stalk may be confined to a very small area, but its presence appears to be sufficient to cause the formation of the absciss layer in the leaf stalk, and thus the fall of the leaf is brought about. The formation of this absciss layer is a normal feature of the leaf of the ordinary wintering of Hevea.

Treatment.—The usual treatment for such a disease would be spraying with Bordeaux mixture, and it is desirable that power sprayers should be given exhaustive trial on rubber

* Brunolinum	..	..	.. 1 gallon.
Water	..	..	.. 4 gallons.
Soft soap	..	..	.. 1 lb.

Thoroughly mix to form emulsion. Distribute to coolies in bottles, so that it can be frequently shaken in the field.

estates. Preventive treatment should be adopted. Dead and fallen leaves and pods should be swept up and burnt. Canker in its other forms should be vigorously combated. Dead twigs and branches should be pruned off and burnt.

Pod Disease.

Identification.—The pods do not ripen and burst, but turn black and sodden, and remain hanging on the tree many weeks after the seed should have been shed.

Occurrence.—This type of canker attack develops in wet weather. It is worst in exceptionally wet seasons, and disappears when the rains cease. The fungus may grow through the fruit stalk into the green branch and kill that for some distance, but it has not been found to proceed further.

Treatment.—Diseased pods should be collected and burnt. As far as possible trees should be stripped of diseased pods. All diseased material should be burnt. Dead fruit stalks and twigs should be pruned off and burnt.

Bark Rot.

Identification.—Black vertical lines appear first on the newly tapped bark and then spread up into the renewing bark and down into the untapped bark. Later these lines of dead tissue expand into areas of dead bark. These black vertical lines appear in the wood often to a depth of a half inch from the surface.

Occurrence.—Bark rot is at its worst in exceptionally wet weather, especially in the months from September to December.

Treatment.—Painting the tapped surface with 20 per cent. Carbolineum or 20 per cent. Brunolinum should be adopted both as a curative and preventive measure. Where the black streaks expand into areas and large patches of bark are effected, it is advisable to rest the tree. When bark rot is rife, it is unwise to open a new cut. The dead areas should be scraped free of dead bark and tarred. Great care should be taken not to render the surface of the wood splintery, as this condition retards the healing over.

General Sanitation.

All jungle stumps should be extracted. Some estates have not yet got rid of the *Fomes* which began on their jungle stumps in 1906. A new danger is now present, viz., the Hevea stumps left after thinning out. These serve as centres of origin for *Fomes semitostus*, *Ustulina zonata*, and *Poria hypobrunnea*. When Hevea is felled, the roots must be extracted. It is, of course, cheaper to cut them off at ground level, but it will be more expensive in the end. If it is impossible to get out the root, the tap root should be extracted to a depth of 2 feet, but it should be borne in mind that this is only the second best method. Brown root disease can spread from ringed Grevillea and cacao stumps to Hevea, and it is very probable that this disease will be found to originate on Hevea stumps.

Another danger arises from abandoned tea under rubber. This was found some years ago to serve as a source of *Ustulina*, which spread from the tea to the rubber. It is now giving serious trouble on some estates in connection with Fomes. The tea should therefore be uprooted.

All diseased material, dead fruits, branches, &c., should be systematically removed from the trees and burnt. Dead branches should be pruned off and the cut tarred. No dead wood should be allowed to lie about the estate. After thinning the logs should be removed as rapidly as possible.

Stem disease should be vigorously and unremittingly treated.

Root diseases should be taken in hand at once, and a serious attempt made to stamp out any at its first appearance.

G. BRYCE,

November, 1916. Assistant Botanist and Mycologist.

DEPARTMENT OF AGRICULTURE, CEYLON.

BULLETIN No. 30.

ON THE MODE OF OCCURRENCE OF LATEX VESSELS IN HEVEA BRASILIENSIS.

G. BRYCE, B.Sc., and L. E. Campbell, B.Sc., F.I.C.

Peradeniya,
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ON THE MODE OF OCCURRENCE OF LATEX VESSELS IN HEVEA BRASILIENSIS.

By G. BRYCE, B.Sc., and L. E. CAMPBELL, B.Sc., F.I.C.

IN the tapping of *Hevea brasiliensis* on rubber estates the distribution and mode of occurrence of latex vessels in the cortex are obviously of great importance, as factors influencing the amount of latex obtainable. The earliest investigations on the distribution of laticiferous tissue in *Hevea* were carried out in 1885 by Scott.* These, however, refer to the origin and distribution of the laticiferous tissue in seedlings and not of trees. Subsequent work on seedlings was carried out in 1887 by Miss Calvert,† who observed that in the upper part of the stems of older seedlings the latex tubes in the hypoderm or outer cortex seem to arise as branches from the main system of tubes in the inner cortex. Vernet‡ in 1908 described a typical example of the mature cortex of *Hevea*, and records that he observed in rare cases connections between adjacent rows of latex vessels, an observation which subsequent workers have so far failed to confirm.

In 1911 Arens§ published a description of typical *Hevea* cortex, and stated that there is no connection between neighbouring rows.

In the " Mémoires Scientifiques (1912) " published by the Colonial Agriculture Department of Belgium, Dr. Alphonse Meunier describes the laticiferous systems of various trees, including *Hevea brasiliensis*. He found that the rows of latex vessels appear at regular distances, being separated from each other by about ten cortical cells, and that the rows are not connected one with another.

* Scott, Jour. Linn. Soc., Vol. XXI., pp. 566–573.
† Calvert, Ann. of Bot., Vol. I., pp. 75–76.
‡ Vernet, Le Caoutchouc et la Gutta-Percha.
§ Arens, Alg. Proefstation op Java., III. Serie, No. 3.

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Simon* working at Buitenzorg in 1913 confirmed previous work, re-affirming that latex vessels are arranged in networks of separate and non-communicating cylinders. Lock† also failed to detect connections between adjacent cylinders, and mentions that about five rows of cortical cells separate one cylinder from the next.

In 1914 Richards and Sutcliffe‡ remarked that the number of cylinders or rows of latex vessels varies considerably.

Up to the present, however, there is no record of any investigations into the number of cylinders at different heights of the stem in mature trees, or of any seasonal variation in these numbers.

A more detailed investigation than had hitherto been carried out was therefore considered necessary to elucidate the many obscure points in connection with this subject. Among questions to be investigated were the following :—

(1) Structure of cortex.

(2) Variation in the number of rows of latex vessels at different seasons.

(3) Variation in the number of rows of latex vessels at various heights in the same tree.

(4) Distances between rows of latex vessels.

(5) Presence or absence of connections between neighbouring rows.

(6) Course of the rows, whether regular or irregular.

(7) Relation between the total thickness of the cortex and number of rows of latex vessels.

(8) Distance from the cambium at which the rows of latex vessels commence to disintegrate.

For the purpose of our investigations we selected a number of untapped trees at the Experiment Station, Peradeniya. These trees were planted in 1905. To confirm the results obtained, we also examined trees growing on plantations in several different districts of Ceylon.

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* Simon, Tropenpflanzer, XVII., 1913, Nos. 2, 3, 4.

† Lock, "Rubber and Rubber Planting," p. 45.

‡ Richards and Sutcliffe, "Hevea brasiliensis" published by the Malay Agricultural Association.

Method of Examination.

The circumference of the stem was divided into four parts at 8 feet and 2 feet from the ground, and portions of cortex about 1 inch square were removed from each and fixed in chrome-acetic acid. It soon became evident, however, that this treatment was undesirable owing to the action of chromic acid on the tannin present in the cortex, a dark coloured compound being formed, which rendered difficult the detection of the latex vessels.

Fixation with chrome-acetic was therefore omitted, and the portions of cortex were placed directly in alcohol in order to extract as much of the tannin as possible. Immersion in 80 per cent. alcohol for at least one month was found to be sufficient to remove most of the tannin and to render the tissue sufficiently hard for cutting. On microscopic examination of sections so prepared, it was found that the latex vessels stood out distinctly.

The latex vessels can only be satisfactorily detected by the presence in them of coagulated rubber, which has under the microscope a characteristic appearance. In microtome sections which have been cut too thin the rubber is dragged out of the cells in the form of strands. Further, the cutting of sections of *Hevea* cortex offers extraordinary difficulties owing to the presence of the well-known stone cells, which frequently cause the cortex to crumble away before the knife. The sections obtained from the microtome were at first stained, as is usual in botanical work. This process was subsequently abandoned, as it was found that latex vessels were more easily recognized in unstained sections. Sections were permanently mounted in glycerine.

Structure of Cortex.

If the latex vessel system could be dissected out of the cortex, it would be found to consist, in the main, of a number of superimposed cylindrical networks. If, therefore, a complete transverse section of a rubber tree were examined, these cylinders would appear as a series of concentric circles. When only a small section of cortex is examined, the portions of the cylinders present appear in a transverse section as parallel rows or lines.

There are two, clearly distinguishable, though not sharply demarcated, zones in *Hevea* cortex; namely :—

(1) The inner cortex, from which stone cells are absent. Here the rows of latex vessels are continuous.

(2) The outer cortex, abounding in groups of stone cells, the development of which eventually breaks up and displaces the rows of latex vessels.

Hence in the inner cortex the rows of latex vessels are clearly defined. In the outer cortex the rows are at first interrupted to a small extent only, but further out the increasing number of stone cells causes so great interruption that only isolated latex vessels can be detected.

The cambium gives rise to wood cells internally and to cortical cells externally. The elements forming the cortex consist of latex vessels, the various phloem cells, and medullary ray cells. A row of latex vessels is laid down by the cambium, and then several rows of cortical cells. The number of the latter varied to some extent in each of the sections examined. The medullary ray cells are laid down in continuation with the medullary rays of the wood ; they remain narrow and distinct in the inner cortex, broadening out and finally disappearing in the outer cortex. The inner cortex is free from stone cell groups ; these latter arise in the cortex by the lignification of cortical cells. In this stone-cell-free region of the cortex the rows of latex vessels pursue a regular uninterrupted course. The formation of stone-cell groups first occurs between rows of latex vessels, and then by their subsequent growth throw the rows of latex vessels out of their course, so that where stone-cell groups are abundant, only isolated latex vessels remain to indicate a former row. There is a considerable variation in the number of stone cells present in the cortex of different trees, varying from extreme abundance to comparative scarcity. Further, in the same tree the cortex at 8 feet contains relatively more stone cells than the cortex at 2 feet from the ground. In the outer layers of the cortex the latex vessels could no longer be detected. The content apparently coagulates before the tissue is cut off by the cork cambium. Changes occur in the other cortical cells as they become more distant from the cambium. The medullary

rays disappear, the rectangular cortical cells become roughly spherical, and acquire for the most part an abundant tannin content. The outermost cortical region usually shows a complete ring of stone cells. Outside this are a few cortical cells, the cork cambium, cork cells, and the dead bark scales.

In the inner cortex one can frequently recognize latex vessels, even when the rubber content has been extracted with xylol. They are recognizable by the smaller diameter of the cells immediately adjoining the latex vessels, in comparison with that of the surrounding cortical cells.

Variation in the Number of Rows of Latex Vessels at different Seasons.

Our object was to ascertain whether the formation of new latex vessels takes place regularly all the year round, or occurs more actively at any particular season or seasons. It should be observed here that as no actual work in this connection had hitherto been carried out, it was necessary to study the question from several points of view.

Selected trees were divided into groups to be examined at intervals of one month, one fortnight, and one week. To determine the direction of formation we took into account the possibility of—

(1) Formation of latex vessels at a uniform rate all over the stem.

(2) Progressive formation of latex vessels from the base of the tree upwards, or *vice versâ*.

For this purpose it was deemed necessary to take simultaneously two sections, one at 2 feet from the ground and the other directly above at 8 feet from the ground.

In every case, except that of the tree which was examined fortnightly, sections were taken in succession from each quarter at the heights named. The fortnightly tree was examined six times in all, six sections being taken at each of the two levels, instead of four as in the other cases.

Three sets of investigations were commenced in August, 1915. They consisted of trees examined—

(1) At monthly intervals.

(2) At fortnightly intervals.

(3) At weekly intervals.

In (1) the investigations covered a period of twelve months, (2) and (3) were designed to cover the period of greatest girth-increase, which, in Ceylon, takes place from August to November.

Method of recording Results.—On examining a transverse section of the cortex of *Hevea*, it is seen that the rows of latex vessels are, at a certain distance from the cambium, slightly interrupted by individual stone-cell groups, and finally, with the increasing number of the latter, become completely disintegrated, this effect being roughly proportional to the distance from the cambium. The general change in the structure of the cortex which occurs at the same time also assists in bringing about this result.

For purposes of description we have found it convenient to record separately the complete rows and the rows which, though interrupted by stone-cell groups, are nevertheless recognizable as such. These we have designated " complete " and " interrupted " rows respectively. In the following table we give the number of complete rows and the total number of rows (complete + interrupted) :—

Trees examined at Intervals of One Month.

No. of Tree :—	*82 C 49.*				*82 B 19.*				*82 B 50.*			
	Number of Rows of Latex Vessels.											
Month.	Complete.		Total.		Complete.		Total.		Complete.		Total.	
	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.
Aug. 5 ..	7	8	8	10	4	6	6	9	6	7	7	10
Sept. 2 ..	4	10	5	11	4	8	6	11	5	6	7	9
Oct. 2 ..	4	8	6	11	8	7	11	9	7	8	8	10
Nov. 5 ..	7	8	9	10	5	8	6	10	7	7	9	12
No. of Trees :—	*81 B 49*				*81 B 50.*				*81 A 46.*			
Dec. 8 ..	5	12	8	16	5	6	9	9	9	9	10	11
Jan. 10 ..	5	12	8	16	4	8	6	10	5	9	7	10
Feb. 3 ..	4	8	7	11	4	5	5	8	5	6	7	8
Mar. 10 ..	5	10	7	12	4	7	7	9	6	7	6	8
No. of Trees :—	*81 B 43.*				*81 A 39.*				*81 A 40.*			
April 17 ..	6	13	9	16	6	9	8	10	8	8	9	10
June 9 ..	11	11	13	16	6	8	8	10	8	8	9	13
June 28 ..	8	14	10	15	7	8	8	8	8	7	10	13
July 12 ..	6	12	8	12	7	9	8	9	7	7	10	13

Trees examined at Intervals of One Fortnight.

No. of Tree :— *81 C 47.*

Date.		Number of Latex Vessels. Complete. At 8 Ft.		At 2 Ft.		Total. At 8 Ft.		At 2 Ft
August 5	..	6	..	7	..	8	..	10
August 21	..	6	..	7	..	8	..	9
September 2	..	6	..	8	..	9	..	12
September 17	..	6	..	8	..	9	..	12
October 2	..	6	..	6	..	11	..	10
October 16	..	6	..	8	..	8	..	10

Trees examined at Intervals of One Week.

No. of Tree :— *82 B 48.*

Date.		Number of Rows of Latex Vessels. Complete. At 8 Ft.		At 2 Ft.		Total. At 8 Ft.		At 2 Ft.
August 5	..	8	..	8	..	12	..	10
August 13	..	7	..	7	..	10	..	10
August 21	..	7	..	7	..	11	..	10
August 26	..	8	..	10	..	10	..	13

No. of Tree :— *81 C 50.*

September 2	..	9	..	12	..	11	..	15
September 9	..	7	..	12	..	9	..	15
September 17	..	7	..	12	..	10	..	17
September 23	..	9	..	12	..	11	..	13

No. of Tree :— *81 B 52.*

October 2	..	7	..	11	..	9	..	13
October 8	..	8	..	14	..	9	..	17
October 16	..	6	..	7	..	7	..	11
October 22	..	6	..	10	..	7	..	13

No. of Tree :— *81 B 51.*

October 30	..	9	..	10	..	13	..	14
November 5	..	7	..	12	..	11	..	15
November 16	..	8	..	12	..	11	..	15
November 20	..	9	..	14	..	9	..	16

Trees examined at Monthly Intervals.—In order to reduce the figures in the preceding tables to a form convenient for comparison, we have added together the numbers of rows in

each month in the three trees under examination in that month and append them in the following table :—

Tree No.		Number of Rows of Latex Vessels. At 8 Ft. from Ground. Complete.	At 8 Ft. from Ground. Total.	At 2 Ft. from Ground. Complete.	At 2 Ft. from Ground. Total.
82 C 49, 82 B 49, 82 B 50	August	17	21	21	29
	September	13	18	24	31
	October	19	25	23	30
	November	19	24	23	32
81 B 49, 81 B 50, 81 A 46	December	19	27	27	36
	January	14	21	29	36
	February	13	19	19	27
	March	15	20	24	29
81 B 43, 81 A 39, 81 A 40	April	20	26	30	36
	June 9	25	30	27	39
	June 28	23	28	29	36
	July	20	26	28	34

In the three groups in the above table it must be noted that comparisons can be drawn only between figures of the same group. In the first group, August to November, no variation exceeding the limits of experimental error can be detected.

In the second group, however, there is a pronounced decrease in the number of rows of latex vessels in the month of February. In the following month the numbers appear to be be again approaching the normal. The decrease in February is particularly notable in the sections taken at 2 feet from the ground, and amounts to 25 per cent. of the totals in both December and January. The decrease in the number of *complete* rows at 2 feet from the ground amounts to 35 per cent. of the number of *complete* rows for January. In March the number of rows at 2 feet from the ground increases somewhat, but is still below normal.

In the period April to July no change of any magnitude is observable.

We thus conclude that in the case of these trees there are good grounds for assuming that there was a diminished production of latex vessels during the period in which the trees were undergoing change of leaf.* It is particularly significant that this decrease was most marked in the complete rows of latex vessels, as it is here that any decreased or increased cambial activity would make itself most readily apparent.

* In Ceylon this takes place during the dry season January to March.

Tree examined at Fortnightly Intervals.—In the tree examined fortnightly no variation of any magnitude was observable.

Trees examined at Weekly Intervals.—The first of the trees which were examined weekly showed in the last section an increase of 30 per cent. in the total number of rows at 2 feet from the ground, and an increase of 43 per cent. in the complete rows at the same height. The variations in the number of rows at 8 feet were unimportant.

In the second tree there was a decrease at 2 feet from the ground only in the last section, and this decrease was not large.

The third tree gave very irregular results, which would appear to indicate variations in the cortex at different parts of the stem rather than a seasonal variation in the production of latex vessels.

The fourth weekly tree showed no variations of any importance.

Variation in the Number of Rows of Latex Vessels at various Heights on the same Tree.

During the examination of trees for seasonal variation in the rows of latex vessels, it soon became apparent that the cortex at 2 feet from the ground almost invariably contained more rows of latex vessels than the cortex at 8 feet from the ground. This fact is illustrated in the tables already given.

To this general rule there were only six exceptions, and of these, in two cases the cortex at 8 feet contained the same number of rows as the cortex at 2 feet from the ground.

To demonstrate more clearly the general rule, the total number of rows in the sections taken from each tree have been tabulated as follows :—

Trees examined Monthly. Four Sections taken from both Levels.

Tree No.	Number of Rows of Latex Vessels. At 8 Ft. from Ground.	At 2 Ft. from Ground.
82 C 49	28	42
82 B 49	29	39
82 B 50	31	41
81 B 49	30	55
81 B 50	27	36
81 A 46	30	47
81 B 43	40	59
81 A 39	32	37
81 A 40	38	49

Trees examined Fortnightly. Six Sections taken from both Levels.

Tree No. 81 C 47.

Number of rows of latex vessels at 8 ft. from ground . . 53
Number of rows of latex vessels at 2 ft. from ground . . 63

Trees examined Weekly. Four Sections taken from both Levels.

Tree No.	Number of Rows of Latex Vessels. At 8 Ft. from Ground.	At 2 Ft. from Ground.
81 C 50	41	60
81 B 52	32	54
81 B 51	44	60

Average number of rows at 8 feet from ground . . 8·4
Average number of rows at 2 feet from ground . . 11·9

It will thus be seen that there was an average difference of 3·5 rows of latex vessels in the cortex at heights of 2 feet and 8 feet from the ground, the cortex at the lower level containing the greater number. This fact was of sufficient importance to indicate that further study was desirable. Sections of untapped bark were therefore taken at intervals from the ground up to a considerable height.

For this purpose we first took sections from the untapped cortex of six trees in the Gampola district. These trees were ten years old at the time of examination.

The results were as follows :—

Tree No. 1.

	Number of Rows of Latex Vessels. Complete.	Total.
Section 1 at ground level	13	15
2 at 2 ft. from the ground	4	6
3 at 4 ft. do.	5	6
4 at 8 ft. do.	4	5
5 at 12 ft. do.	5	6
6 at 16 ft. do.	3	5
7 at 20 ft. do.	5	6
8 at 24 ft. do.	4	6

Tree No. 2.

	Complete.	Total.
Section 1 at ground level	5	5
2 at 2 ft. from the ground	4	4
3 at 4 ft. do.	5	6
4 at 8 ft. do.	5	5
5 at 12 ft. do.	5	5
6 at 16 ft. do.	5	5
7 at 20 ft. do.	5	5

Tree No. 3.

	Number of Rows of Latex Vessels. Complete.	Total.
Section 1 at ground level ..	7 ..	8
2 at 2 ft. from the ground ..	5 ..	5
3 at 4 ft. do. ..	4 ..	5
4 at 8 ft. do. ..	3 ..	4
5 at 12 ft. do. ..	4 ..	4
6 at 16 ft. do. ..	2 ..	3
7 at 20 ft. do. ..	3 ..	4

Tree No. 4.

Section 1 at ground level ..	6 ..	6
2 at 2 ft. from the ground ..	5 ..	5
3 at 4 ft. do. ..	4 ..	6
4 at 8 ft. do. ..	4 ..	6
5 at 12 ft. do. ..	5 ..	6
6 at 16 ft. do. ..	4 ..	6
7 at 20 ft. do. ..	4 ..	5
8 at 24 ft. do. ..	3 ..	5
9 at 28 ft. do. ..	3 ..	3
10 at 32 ft. do. ..	3 ..	3

Tree No. 5.

Section 1 at ground level ..	9 ..	9
2 at 2 ft. from the ground ..	8 ..	8
3 at 4 ft. do. ..	6 ..	6
4 at 8 ft. do. ..	5 ..	6
5 at 12 ft. do. ..	5 ..	6
6 at 16 ft. do. ..	5 ..	6
7 at 20 ft. do. ..	4 ..	6
8 at 24 ft. do. ..	4 ..	5
9 at 28 ft. do. ..	3 ..	6
10 at 32 ft. do. ..	3 ..	6

Tree No. 6.

Section 1 at ground level ..	12 ..	12
2 at 2 ft. from the ground ..	6 ..	7
3 at 4 ft. do. ..	7 ..	8
4 at 8 ft. do. ..	6 ..	7
5 at 12 ft. do. ..	5 ..	5
6 at 16 ft. do. ..	5 ..	7
7 at 20 ft. do. ..	5 ..	7
8 at 24 ft. do. ..	4 ..	6

It will be observed that in these trees the number of latex vessels in the cortex at the base of the tree was usually markedly greater than in the cortex higher up the stem.

We then examined six trees from the Matale District. They had an average girth of 17·3 inches a 3 feet from the ground.

The following results were obtained :—

Tree No. 7.

	Number of Rows of Latex Vessels. Complete.	Total.
Section 1 at ground level	17	17
2 at 2 ft. from the ground	11	11
3 at 4 ft. do.	4	6
4 at 8 ft. do.	4	4
5 at 12 ft. do.	4	6
6 at 16 ft. do.	3	3

Tree No. 8.

Section 1 at ground level	8	10
2 at 2 ft. from the ground	6	7
3 at 4 ft. do.	4	4
4 at 8 ft. do.	4	4

Tree No. 9.

Section 1 at ground level	5	11
2 at 2 ft. from the ground	3	5
3 at 4 ft. do.	3	5
4 at 7 ft. do.	4	4

Tree No. 10.

Section 1 at ground level	13	17
2 at 2 ft. from the ground	4	5
3 at 4 ft. do.	2	3
4 at 8 ft. do.	4	5
5 at 12 ft. do.	3	4
6 at 16 ft. do.	3	3

Tree No. 11.

Section 1 at ground level	10	12
2 at 2 ft. from the ground	5	6
3 at 4 ft. do.	3	5
4 at 8 ft. do.	4	7
5 at 12 ft.* do.	4	6

Tree No. 12.

Section 1 at ground level	7	9
2 at 2 ft. from the ground	6	7
3 at 4 ft. do.	4	5
4 at 8 ft.* do.	4	6

* Taken above junction of branches with stem.

In these trees the previous results were confirmed. The difference in the number of rows of latex vessels was, however, much more marked.

In three trees the greatest difference was found to be between the heights of 3 feet and 4 feet. In the other three cases the maximum difference occurred between ground level and 2 feet above it.

Sections were then taken from a tree in a twelve-year old clearing in Kalutara. The girth of the tree was $29\frac{1}{2}$ inches at 3 feet from the ground.

The numbers of rows of latex vessels at various heights were as follows :—

Tree No. 13.

	Number of Rows of Latex Vessels. Complete.	Total.
Section 1 at 1 ft. from the ground	8	24
2 at 2 ft. do.	6	19
3 at 4 ft. do.	6	12
4 at 8 ft. do.	5	10
5 at 12 ft. do.	4	8
6 at 16 ft. do.	4	8
7 at 20 ft. do.	4	7

In this case there was a remarkable number of rows of latex vessels in the lower part of the tree, no less than twenty-four rows being present at a height of 1 foot from the ground.

The greatest decrease occurred between the heights of 2 feet and 4 feet.

A tree from an estate in the Kelani Valley gave the following results, the girth at 3 feet from the ground being 35 inches :—

Tree No. 14.

	Number of Rows of Latex Vessels. Complete.	Total.
Section 1 at 2 ft. from the ground	9	14
2 at 4 ft. do.	9	14
3 at 8 ft. do.	7	13
4 at 12 ft. do.	5	11
5 at 16 ft. do.	4	6
6 at 20 ft. do.	4	8

Here the decrease in the number of latex vessels according to the height above ground level was considerably more gradual than in the previous cases.

Up to 12 feet from the ground the number of rows of latex vessels was markedly uniform, there being a difference of only three rows between the cortex at 2 feet and that at 12 feet from the ground. In this case it was impossible to get a sample of untapped cortex at less than 2 feet from the ground.

In general it may be said that the number of rows of latex vessels decreases with the height above ground level. In many cases a very large variation occurs in the region subjected to tapping, namely, the part of stem from ground level to 4 feet above it. It is not difficult to realize that these variations have an important bearing on rubber yields and on tapping experiments.

Distance between Rows of Latex Vessels.

In view of the fairly prevalent opinion that the distance between the rows of latex vessels increases with the distance from the cambium, it seemed desirable that measurements should be taken in order to ascertain whether this is the normal arrangement of latex vessels in the cortex. It was also considered possible that these measurements might yield other data of interest.

In the following tables of measurements the row nearest the cambium has been designated No. 1, the others following in numerical succession :—

Tree No. 82 C 49.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.
1–2	·2	·25	·2	·4
2–3	·2	·2	·25	·25
3–4	·3	·25	·4	·4
4–5	·25	·2	—	·15
5–6	·25	·15	—	·25
6–7	·25	·15	—	·2
7–8	—	·2	—	·27
8–9	—	—	—	·3
9–10	—	—	—	·4
Average	·24	·2	·28	·29

Tree No. 82 B 49.

Distance in Millimetres.

Row No.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.	Section No. 3. At 8 Ft.	Section No. 3. At 2 Ft.
1–2	·3	·2	·2	·25
2–3	·5	·2	·2	·3
3–4	·3	·25	·25	·2
4–5	—	·25	·25	·15
5–6	—	·2	·25	·2
6–7	—	·3	·2	·25
7–8	—	·3	·25	—
Average	·37	·24	·23	·22

Tree No. 82 B 50.

Row No.	Distance in Millimetres. Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.
1–2	·3	·3	·3	·3
2–3	·25	·3	·35	·25
3–4	·15	·3	·45	·25
4–5	·2	·3	·4	·4
5–6	·15	·25	—	·4
6–7	—	·3	—	—
Average	·21	·29	·37	·32

Tree No. 81 B 49.

Row No.	Distance in Millimetres. Section No. 4. At 8 Ft.	Section No. 4. At 2 Ft.
1–2	·3	·1
2–3	·4	·5
3–4	·25	·2
4–5	·25	·1
5–6	—	·25
6–7	—	·1
7–8	—	·17
8–9	—	·1
9–10	—	·17
Average	·3	·19

Tree No. 81 A 46.

Row No.	Distance in Millimetres. Section No. 4. At 8 Ft.	Section No. 4. At 2 Ft.
1–2	·1	·27
2–3	·3	·25
3–4	·25	·3
4–5	·3	·4
5–6	·35	·4
Average	·26	·32

Tree No. 81 B 43.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 3. At 8 Ft.	Section No. 3. At 2 Ft.
1–2	4	·15	·2	·1
2–3	·4	·25	·15	·2
3–4	·2	·15	·2	·2
4–5	·3	·15	·1	·15
5–6	·25	·1	·1	·2
6–7	·3	·17	·1	·2
7–8	—	·1	—	·15
8–9	—	·1	—	·15
9–10	—	·1	—	·1
10–11	—	·2	—	·1
11–12	—	·1	—	·1
12–13	—	·1	—	·1
13–14	—	·1	—	·1
14–15	—	—	—	·1
Average	·31	·14	14	·14

Tree No. 81 A 40.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.	Section No. 3. At 8 Ft.	Section No. 3. At 2 Ft
1–2	·15	·1	·15	·1	·1	·1
2–3	·1	·1	·1	·12	·2	·1
3–4	·2	·1	·2	·1	·1	·15
4–5	·2	·3	·25	·1	·2	·25
5–6	·4	·45	·4	·25	·4	·15
6–7	·4	·1	·35	·3	·3	·25
7–8	—	·1	—	·2	—	·25
Average	·24	·18	·24	·17	·22	·18

Tree No. 81 C 47.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 5. At 8 Ft.	Section No. 5. At 2 Ft.
1–2	·2	·2	·3	·1
2–3	·2	·2	·4	·2
3–4	·15	·3	·35	·3
4–5	·25	·22	·3	·27
5–6	·2	·25	·4	·22
6–7	—	·3	—	·2
Average	·2	·24	·35	·21

Tree No. 82 B 48.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.	Section No. 4. At 8 Ft.	Section No. 4. At 2 Ft.
1–2	·2	·2	·2	·3	·2	·1
2–3	·3	·1	·2	·35	·25	·25
3–4	·25	·1	·2	·35	·15	·3
4–5	·2	·2	·2	·2	·25	·2
5–6	·2	·2	·1	·35	·2	·17
6–7	·2	·2	·15	·25	·2	·15
7–8	·2	·2	—	—	·1	·27
8–9	—	—	—	—	—	·1
9–10	—	—	—	—	—	·2
Average	·22	·17	·17	·3	·19	·19

Tree No. 81 C 50.

Distance in Millimetres.

Row No.	Section No. 1. At 8 Ft.	Section No. 1. At 2 Ft.	Section No. 2. At 8 Ft.	Section No. 2. At 2 Ft.	Section No. 3. At 8 Ft.	Section No. 3. At 2 Ft.
1–2	·3	·1	·2	·25	·2	·2
2–3	·3	·15	·25	·15	·2	·15
3–4	·2	·15	·2	·2	·35	·17
4–5	·3	·1	·25	·3	·3	·12
5–6	·25	·2	·35	·2	·2	·1
6–7	·15	·15	·55	·3	·2	·1
7–8	·15	·25	—	·45	—	·1
8–9	—	·15	—	·25	—	·25
9–10	—	·1	—	·25	—	·17
10–11	—	·1	—	·20	—	·3
11–12	—	·13	—	·15	—	·3
12–13	—	·25	—	—	—	—
13–14	—	·20	—	—	—	—
14–15	—	·50	—	—	—	—
Average	·24	·18	·3	·25	·24	·18

A perusal of the above tables demonstrates that the distance between the rows by no means increases in proportion to the distance from the cambium. In approximately 40 per cent. of the cases there was such an increase, but this increase was neither regular nor of any great magnitude. The distance between the rows would not appear to be a factor peculiar to any individual tree. The average of the distances between the rows as given in the above tables was :—

At 2 feet from the ground	..	0·22 mm.
At 8 feet from the ground	..	0·25 mm.

In a few cases the rows appeared in couples, evidently indicating spasmodic cambial activity.

Presence or Absence of Connections between neighbouring Rows.

In some cases we observed what at first appeared to be anastomoses, or connections, between neighbouring rows of latex vessels. These cases were very few in proportion to the number of sections examined, and on closer examination many were found to be in reality examples of bifurcation of the rows, the two branches thus formed often re-uniting further on. In other cases the apparent anastomosis consisted of bifurcation of one row in close proximity to a neighbouring row, which the offshoot branch approached very closely. Well-defined cases of anastomosis were not observed, but the irregular formation of latex vessels from the cambium, as indicated in the above-mentioned cases of bifurcation, renders not improbable the occasional occurrence of anastomosis.

Course of Rows, whether Regular or Irregular.

In addition to bifurcating rows, we have further cases of irregularity, chiefly in the form of the rows as exhibited in transverse sections of the cortex. The normal condition appears to be that the rows pursue a parallel course and appear in transverse sections as straight lines. Occasionally, however, the rows undulate, and are by no means parallel. In other cases the latex vessels are not grouped into distinct rows, but are scattered throughout the cortex.

Relation between the Total Thickness of the Cortex and Number of Rows of Latex Vessels.

On plantations variation in the thickness of the cortex of different trees is a well-known feature, trees often being distinguished as "thin-barked" or "thick-barked." No connection so far has been determined between yield of latex and thickness of the cortex. The question naturally arises as to whether there are more rows of latex vessels in the cortex of "thick-barked" trees than in that of "thin-barked" trees. Measurements were therefore made of the thickness of the sections of cortex, the dead external corky matter being excluded. These measurements are appended in the following table, together with the number of rows of latex vessels present in each case :—

Thickness of Cortex and Rows of Latex Vessels.

Tree No.			Section 1.		Section 2.		Section 3.		Section 4.	
			Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.
82 C 49 :	At 8 ft.	..	5	8	4·5	5	4·5	6	6	9
	At 2 ft.	..	7	10	6·5	11	7	11	6	10
82 B 49 :	At 8 ft.	..	6	6	5·5	6	5	11	5·5	6
	At 2 ft.	..	6	9	6·5	11	6·5	9	6·5	10
82 B 50 :	At 8 ft.	..	5	7	6	7	6	8	5·5	9
	At 2 ft.	..	8	10	8	9	8·5	10	8	12
81 B 49 :	At 8 ft.	..	4	8	5	8	3·5	7	4·5	7
	At 2 ft.	..	5·5	16	5·5	16	4·5	11	4·5	12
81 B 50 :	At 8 ft.	..	5	9	5·5	6	5	5	4	7
	At 2 ft.	..	5	9	6·5	10	6·5	8	6	9
81 A 46 :	At 8 ft.	..	3·5	10	4	7	5	7	5·5	6
	At 2 ft.	..	5·5	11	5·5	10	5	8	6	8
81 B 43 :	At 8 ft.	..	5	9	6·5	13	5·5	10	5	8
	At 2 ft.	..	7	16	7·5	16	7·5	15	8	12
81 A 39 :	At 8 ft.	..	6	8	6	8	6·5	8	6	8
	At 2 ft.	..	8	10	8	10	9	8	7·5	9
81 A 40 :	At 8 ft.	..	6·5	9	6	9	6	10	7	10
	At 2 ft.	..	8	10	8·5	13	7·5	13	8	13
82 B 48 :	At 8 ft.	..	6	12	6·5	10	6	11	6·5	10
	At 2 ft.	..	6·5	10	7	10	7	10	7·5	13
81 C 50 :	At 8 ft.	..	7	11	6·5	9	7	16	6·5	11
	At 2 ft.	..	8	15	9	15	9	17	9	13
81 B 52 :	At 8 ft.	..	5	9	5·5	9	6	7	5	7
	At 2 ft.	..	7	13	7·5	17	8	11	7	13
81 B 51 :	At 8 ft.	..	4·5	13	5	11	5·5	11	6	9
	At 2 ft.	..	5·5	14	5	15	6·5	15	6	16

Tree No. 81 C 47.

	Section 1.		Section 2.		Section 3.		Section 4.		Section 5.		Section 6.	
	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.	Thickness of Cortex in Millimetres.	Number of Rows.
At 8 ft. ..	6	8	6	8	7	9	7·5	9	7	11	6·5	8
At 2 ft. ..	8	10	8	9	8	12	6·5	12	8·5	10	8·5	10

The readings in the preceding table are capable of being grouped according to the thickness of the cortex. In the following table the various thicknesses of the cortex at 8 feet and at 2 feet from the ground have been arranged in numerical order, together with the averages of the numbers of rows of latex vessels in these thicknesses. As in some cases there were only a few specimens of one particular thickness and many specimens of other thicknesses, the numbers of specimens are given from which the averages were taken. For instance, an average of two or three figures will not be so representative of the normal for that thickness as an average of twelve or fifteen figures for another thickness. Too great importance must, therefore, not be attached to an average derived from a few figures, as some of these may have been abnormal :—

Various Thicknesses of Cortex and Average Number of Rows present.

At 8 Feet.			At 2 Feet.		
Thickness of Cortex in Millimetres.	Number of Sections of this Thickness.	Average Number of Rows.	Thickness of Cortex in Millimetres.	Number of Sections of this Thickness.	Average Number of Rows.
3·5	2	8·5	4·5	2	11·5
4·0	3	7·3	5·0	3	10·7
4·5	4	7·7	5·5	5	13·4
5·0	12	8·2	6·0	5	10·4
5·5	8	8·0	6·5	9	10·7
6·0	15	8·5	7·0	7	11·9
6·5	8	9·7	7·5	6	13·8
7·0	5	10·2	8·0	13	13
7·5	1	9·0	8·5	4	10·7
—	—	—	9·0	4	13·2

It will be gathered from the foregoing table that in cortex at 8 feet from the ground there is, with increasing thickness of cortex, a distinct though not large increase in the number of

rows of latex vessels. The same remark may be applied to the sections taken at the lower level, though here the increase is smaller than in the previous case.

Distance from the Cambium at which the Rows of Latex Vessels commence to disintegrate.

A factor which profoundly influences the yield of latex from a tree is the depth of the tapping cut. The nearer the tapping cut penetrates to the cambium, the greater the yield. It has been stated elsewhere that in the cortex the innermost rows of latex vessels are complete, those further out becoming interrupted and finally totally disintegrated. It is, however, impossible to tap all the complete rows owing to the fact that most of these are contained in the inner cortex or food-conducting tissue of the tree, which tissue must not be severed. Where complete rows extend into the area pared by the tapping knife, the yield of latex will be greater than in cases where only interrupted rows are present. It might be suggested that the latex-yielding properties of trees are in part determined by the extent to which rows of latex vessels exist uninterrupted at some distance from the cambium. Measurements were accordingly made of the distance from the cambium of the first interrupted row in the various sections examined under the microscope.

Distance in Millimetres from Cambium at which Rows commence to disintegrate.

Tree No.		Section 1.		Section 2.		Section 3.		Section 4.	
		At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.	At 8 Ft.	At 2 Ft.
82 C 49	..	1·4	1·6	1·0	3·0	1·2	1·7	1·6	1·8
82 B 49	..	1·0	1·7	1·2	1·6	1·2	1·5	1·7	1·5
82 B 50	..	1·1	1·0	1·1	1·5	1·5	1·7	2·0	1·8
81 B 49	..	1·1	2·4	1·1	1·8	1·0	1·5	1·0	2·2
81 B 50	..	1·0	1·2	1·0	1·5	1·0	1·0	1·0	1·2
81 A 46	..	1·7	1·2	0·9	1·3	1·0	1·4	1·4	1·2
81 B 43	..	1·3	1·7	1·4	1·4	1·4	1·4	1·2	1·2
81 A 39	..	1·4	1·3	1·0	1·9	1·5	1·6	1·5	1·2
81 A 40	..	1·2	1·5	1·6	1·3	1·4	1·3	1·2	1·5
82 B 48	..	1·7	2·0	1·3	1·8	1·4	2·5	2·0	2·3
81 C 50	..	2·0	3·0	1·4	2·6	1·5	2·2	1·6	2·5
81 B 52	..	1·5	1·9	1·7	2·0	1·8	1·6	1·7	2·0
81 B 51	..	1·4	2·0	1·2	2·1	1·2	2·7	1·2	2·3
Average	..	1·37	1·73	1·22	1·83	1·32	1·70	1·47	1·75

Tree No.	Section 1. At 8 Ft.	Section 1. At 2 Ft.	Section 2. At 8 Ft.	Section 2. At 2 Ft.	Setcion 3. At 8 Ft.	Setcion 3. At 2 Ft.	Section 4. At 8 Ft.	Section 4. At 2 Ft.	Section 5. At 8 Ft.	Section 5. At 2 Ft.	Section 6. At 8 Ft.	Section 6. At 2 Ft.
81 C 47 ..	1·7	1·7	1·6	1·3	1·8	1·5	1·5	2·0	1·7	1·5	1·8	1·5

It will be noted that the average distance is greater at 2 feet than at 8 feet from the ground. The average distance at 2 feet is 1·54 mm., and at 8 feet is 1·34 mm. It may be said that in the average case a thickness of cortex of 1·5 mm. should be left untapped, this being the tissue next to the cambium.

Summary.

(1) Considerable variation occurs in the number of stone cells in the cortex of different trees. There is consequently variation in the degree of disintegration of the latex vessels.

(2) There was evidence of the diminished production of latex vessels in February and March, when the trees were changing leaf.

(3) The number of rows of latex vessels in the cortex decreases with the height above ground level.

(4) The distance between the rows of latex vessels did not usually increase in proportion to the distance from the cambium. The average of the distances between the rows was approximately 0·2 millimetres.

(5) Well-defined cases of connections between neighbouring rows of latex vessels were not observed. Several examples of bifurcation of rows were, however, noted.

(6) The course of the rows may not be invariably regular and parallel. Sometimes the rows undulate, and the same neighbouring rows vary in distance apart at different points.

(7) In general the thicker the cortex the more rows of latex vessels did it contain, though the increase was not great.

(8) The distance from the cambium of the first interrupted row was approximately 1·5 millimetres; this represents the inner cortex or food-conducting tissue of the tree, and should be left untapped.

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